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Analysis of Oil and Fat Content in Palm Oil Industry Wastewater Gravimetric Analysis

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Abstract. Wastewater is unused waste water and contains many substances that can pollute the environment and disturb the health of living things. One of the parameters of wastewater pollution that is found in everyday life is oil and fat. Oil and fat are one of the parameters in wastewater consisting of compounds that can pollute water bodies so that their concentration must be limited, because their impact can damage aquatic ecosystems, especially on water resources. Oil and fat are compounds that contain the main component, triglycerides. Triglycerides are molecules resulting from condensation between one glycerol and three fatty acids. Based on SNI 6989.10: 2011 from the Regulation of the Minister of Environment No.05 of 2014, states that the maximum concentration of oil and fat quality standards contained in wastewater from the palm oil industry is 25 mg/L. The results of the analysis that has been carried out show that the levels of oil and fat in the palm oil industry wastewater samples include In-let wastewater (12,4 mg/L), Out-let (8,4 mg/L), Up-stream (3,6 mg/L) and Down-stream (6 mg/L) which have been tested and analyzed using the gravimetric method. The results show that the samples meet the quality standards for oil and grease in wastewater so that they are relatively safe for environmental health.

Keywords : Liquid waste, Oil and Fat, Gravimetry

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Introduction

Liquid waste is unused waste water and contains many substances that can pollute the environment and disturb the health of living things [1]. Materials that can cause environmental pollution problems include organic, inorganic and heavy metal substances with concentrations that exceed the permissible threshold released into the environment. Generally, liquid waste is generated from human, household and industrial activities [2]. Indiscriminate disposal of wastewater can cause problems for the environment. Over time, the waste liquid will change color to dark brown and produce an unpleasant aroma and the aroma causes respiratory diseases in the surrounding people [3]. One type of industrial wastewater that has the potential to pollute the environment in South Sumatra is palm oil industry wastewater. This waste is an agro-industrial organic waste consisting of water, oil and organic solids produced during the processing of fresh palm fruit to produce palm oil. The processing process produces a significant amount of liquid waste and can potentially pollute the surrounding environment [4]. One of the parameters of wastewater pollution that is commonly found in everyday life is oil and grease.

Oils and fats are components that contain the main component, triglycerides. Triglycerides are molecules resulting from condensation between one glycerol and three fatty acids [5]. Fatty acids make up most of the molecular weight of oil, because the physical and chemical properties of triglycerides are determined by the fatty acids that make up the compound [6]. Although both oils and fats are triglyceride compounds, the form of oils and fats can vary at room temperature. Oil is liquid because it has a lower melting point than room temperature, while fat is solid because its melting point is higher. This difference is entirely due to the different melting points of the fatty acid molecules that make up the triglyceride structure in oils and fats [7]. Melting point is influenced by the degree of unsaturation of fatty acids. Oils with a higher degree of unsaturation have a lower melting point. In unsaturated fatty acids, melting point characteristics are influenced by the number of double bonds and the position of double bonds [8].

Oil and fat is one of the parameters in wastewater which consists of compounds that can pollute water bodies so that their concentration must be limited, because their impact can damage aquatic ecosystems, especially water resources [9]. Oil has a density of 0.8 kg / L lower than water 1 kg / L, as a result a thin layer forms on the surface of the water. The oil layer blocks sunlight from penetrating the water, thus disturbing the balance of the food chain. This condition occurs because dissolved oxygen in the water decreases as a result, free oxygen fixation is inhibited [10]. Based on the Indonesian National Standard (SNI) 6989.10: 2011 from the Regulation of the Minister of Environment No. 03 of 2010, it states that the maximum concentration of oil and fat quality standards in industrial wastewater areas that are allowed to enter the environment is 15 mg/L [11]. Then according to the Regulation of the Minister of Environment No. 05 of 2014, states that the maximum concentration of oil and fat quality standards contained in palm oil industry wastewater allowed to enter the environment is 25 mg/L.

Based on these problems, it is necessary to analyze the levels of oil and fat contained in wastewater from the palm oil industry. This aims to determine the quality and safety of wastewater according to the quality standards of oil and fat in wastewater regulated based on SNI 6989.10: 2011. One method that can be used to measure oil and fat content in wastewater is the gravimetric method. Gravimetry is a method with a high level of sensitivity to determine the level of an element or component of a substance after purification or separation [12]. Gravimetry is the simplest method for measuring the concentration of a substance in a sample. This method focuses on measuring the mass or constant weight of a substance in the sample. This method is done by directly weighing the mass of a substance that has been separated from other materials [13].

Experimental

The work procedure in analyzing oil and fat content in palm oil industry liquid waste test samples, which refers to SNI 6989.10: 2011, among others:

Tools and Materials. The equipment used in this analysis includes 50 ml and 250 ml measuring cups, 500 ml separatory funnel, 1 ml measuring pipette, glass funnel , Petri dish and Petri dish clamp, filter paper, oven, desiccator and analytical balance. Then as for the materials used in this analysis,

namely palm oil wastewater samples, n-hexane, anhydrous sodium sulfate (Na2SO4), 1: 1 HCl solution and distilled water.

Sample Preservation. Samples that have been received are then preserved by acidification before testing. Samples are acidified by adding HCl in a ratio of 1:1 until the pH reaches less than 2, which is 1 (usually 1% of the sample volume) as much as 2.5 ml.

Preparation. Petri dishes before being used in the testing process were first oven for 1 hour at 70°C. After drying for 1 hour in the oven, the Petri dish was moved to a desiccator for ± 30 minutes. Next, the Petri dish was weighed using an analytical balance to determine the empty weight of the Petri dish (W0).

Sample Extraction. The previously preserved sample was measured as 250 ml, then put into a separatory funnel, then 30 ml of n-hexane was added. Next, the mixture was shaken vigorously for 2 minutes until the water and organic phases separated. The aqueous phase formed in the lower layer of the separatory funnel was transferred into a beaker, while the organic phase in the upper layer of the separatory funnel was collected into a petri dish that had been prepared by filtering using a glass funnel and filter paper that had been given 10 grams of anhydrous Na2SO4.

Determination of Oil and Fat Content. The samples that have been separated are then dried in the oven for 1 hour at 70°C. After 1 hour of drying, the Petri dish was put into a desiccator for ± 30 minutes. Next, the Petri dish containing the sample was weighed using an analytical balance to determine the final weight of the Petri dish containing the oil and fat sample (W1). The weighed sample was then calculated using the equation 1.

$$= \frac{W_1 - W_0}{V} \times 1000$$

Description:

W_0: mass of an empty petri dish (mg); W_1: mass of the Petri dish containing the oil and fat sample (mg); V: the volume of the sample (ml).

Result and Discussion

Testing of oil and fat content in palm oil industry liquid waste there are 4 test samples, namely In-let, Out-let, Up stream and Down stream wastewater with reference to SNI 6989.10: 2011, using the gravimetric method. The gravimetric method is applied by calculating the difference between the final weight of the sample produced and the initial weight of the sample. Test samples that have been received before analysis are preserved first by increasing the acidity of the sample using HCl in a ratio of 1: 1 until the pH reaches less than 2, namely 1. This aims to inhibit the growth of microorganisms in wastewater, in order to prevent decomposition and chemical changes caused by microbial activity. The preserved samples were then extracted using n-hexane as a solvent, as oils and fats are naturally insoluble in water, but tend to accumulate in the organic phase. The use of n-hexane as an organic solvent, can extract oils and fats from the water phase into the organic phase. N-hexane functions as a binder and separates the phases in oil and fat, namely the non-polar phase (n-hexane) and the polar water (H2O).

This extraction process is carried out by shaking for 2 minutes. It is intended that the organic phase and the water phase are evenly mixed and the extraction rate increases significantly. The n-hexane phase that has been separated is then filtered using filter paper containing anhydrous Na2SO4. Anhydrous Na2SO4 serves to help absorb residual water from the organic phase, improve filtrate purity and reduce emulsion formation in the filtrate. The oil and fat filtrate from the filtration is dried in the oven for 1 hour at 70°C which aims to evaporate the n-hexane solvent and reduce the remaining water content in the oil and fat filtrate, after drying it is then put into a desiccator to cool the Petri dish and the substance in it to room temperature and the use of silica gel in the desiccator serves to absorb the moisture of the Petri dish and the substance in it to remain dry and stable. After cooling, the oil and fat content was weighed and calculated to determine the results, then the oil and fat content was compared with the quality standard of palm oil industry wastewater according to the Regulation of the Minister of Environment No. 5 of 2014 and the Regulation of the Governor of South Sumatra Province No. 8 of 2012 that the maximum concentration allowed, which is 25 mg/L. The results of the testing of oil and fat content in palm oil industry wastewater samples are shown in Table 1.

Based on the analysis results, it shows that the amount of oil and fat contained in the palm oil industry wastewater produced in Table 1 is below

Table 1. Oil and Fat Content Analysis Results

Samples	Oil and Fat Content (mg/L)	Minister of Environment Regulation No.05 of 2014
A (*In-let*)	12,4	Max. 25 mg/L
B (*Out-let*)	8,4	
C (*Up-stream*)	3,6	
D (*Down-stream*)	6	

the maximum concentration, which is 25 mg/L or has met the quality standards for oil and fat in the palm oil industry wastewater testing sample. Based on the analysis results, the oil and fat content in the liquid waste sample at the In-let point is 12,4 mg/L, higher than the Out-let point of 8,4 mg/L, Down-stream of 6 mg/L and Up-stream which has the lowest oil and fat content, which is 3,6 mg/L. The effluent sampling points (In-let, Out-let, Up-stream and Down-stream) are indicators of the level of oil and fat pollution produced by the palm oil industry.

In-let Wastewater. Based on physical observations, In-let wastewater has an unpleasant odor, is dark brown in color and has very concentrated turbidity. This is because the wastewater at the In-let point is the first wastewater from the control basin which is the rest of the factory wastewater production process before treatment or chemical processes are carried out so that it still contains a lot of dirt and harmful chemicals. At this point the wastewater is only subjected to a screening and sedimentation process to separate solids, dirt, garbage and others [14]. The oil and fat content produced at this point is 12,4 mg/L which is slightly greater than the oil and fat content at the Out-let point of 8,4 mg/L, Down-stream of 6 mg/L and Up-stream of 3,6 mg/L.

Out-let Wastewater. Based on physical observations, the wastewater at the Out-let point has a slightly unpleasant odor, clear orange in color and slightly cloudy. At this Out-let point is the final point before discharging wastewater into receiving waters which functions as a place to monitor the quality of wastewater that has gone through a treatment process or chemical process. The process aims to neutralize the state of organic matter in wastewater and remove colloids. The treatment process is carried out using microorganisms that function for organic matter through aerobic and anaerobic processes.

This aerobic process is carried out by microorganisms in the presence of oxygen as an electron acceptor, this process requires activated sludge containing decomposing bacteria. The activated sludge used is a mixture of liquid suspended solids with the addition of bacteria and oxygen. The anaerobic process does not require oxygen to break down the organic material. Furthermore, liquid waste derived from the two processes is disinfected with the addition of chlorine which functions to eliminate bacteria and pathogenic microorganisms contained in liquid waste. After going through the treatment process, the Out-let liquid waste can be discharged directly into the receiving waters [14]. The levels of oil and fat produced at this point are also smaller at 8,4 mg/L than in wastewater at the In-let point but greater than in wastewater at the Up-stream point.

Up-stream Wastewater. Based on physical observations Up-stream wastewater has no odor, is clear white (clear) and not cloudy. This is because wastewater at the Up-stream point is wastewater originating from the upstream point of receiving waters that has gone through a treatment process. The clarity of wastewater at the Up-stream point is because dirt and wastewater from the Out-let point tend to flow downstream a lot, which results in the physical condition of the waste at the Up-stream point being quite good [15]. The oil and fat content produced at this point is much smaller than the wastewater at the Down-stream and Out-let points, which is 3,6 mg/L.

Down-stream Wastewater. Based on physical observations, Down-stream wastewater has a slightly unpleasant odor, clear orange in color and slightly cloudy. This is because wastewater at the Down-stream point comes from the downstream point of receiving waters that have gone through a treatment process so that the quality of the wastewater is much better than In-let and Out-let wastewater but worse than wastewater at the Up-stream point. This is because sewage from upstream and wastewater from the Out-let point tends to flow a lot to the downstream or Down-stream point of the receiving waters.

The entry of chemicals and dirt at the Down-stream point results in the quality of wastewater at this point being worse than at the Up-stream point even though this wastewater has gone through a previous treatment process [15]. This also affects the oil and grease content at the Down-stream point which

is greater by 6 mg/L than at the Up-stream point. This is because odor, color and turbidity are physical parameters that are one of the causes of increased oil and fat levels in wastewater (In-let, Out-let, Up-stream and Down-stream). Changes in unpleasant odor, dark color and turbidity in concentrated wastewater are due to oil and fat particles dispersed in water as a result of which oil and fat levels are high. This physical factor arises due to differences in the processing process at each of the wastewater collection points, so that the resulting oil and fat content is also different at each of the wastewater collection points.

Conclusion

Based on the analysis that has been done, it can be concluded that the levels of oil and fat in the palm oil industry wastewater testing samples at BSPJI Palembang include In-let wastewater (12,4 mg/L), Out-let (8,4 mg/L), Up-stream (3,6 mg/L) and Down-stream (6 mg/L) which have been tested and analyzed using the gravimetric method shows that the samples meet the quality standards for oil and fat in wastewater, so they are relatively safe for environmental health.

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